The Algal Genus *Laurencia* from the Hawaiian Islands, the Philippine Islands and Adjacent Areas

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AFTER A STUDY (Saito, 1967) of the Japanese species of *Laurencia,* I was given an opportunity to study the tropical Pacific species of the genus at the University of Hawaii. Most of the material used for this study was found in the herbarium of Dr. Maxwell S. Doty and was collected from Hawaii, the Philippines, and adjacent areas. Fresh collections, from the island of Oahu in Hawaii made during the period December 1966 through February 1967, by myself and Dr. Gavino Trono, Jr., were also studied. From this material, I identified twenty species of the genus, including four varieties, of which *L. carolinensis* and *L. dotyi* described below, are new to science.

About half the *Laurencia* species in these regions are found in different Asiatic areas (Yamada, 1931; Yamada and Segawa, 1953; Tseng, 1943). There are but few species in common with the Pacific coast of the United States. I plan to study the morphology of these species and, eventually, the phytogeography of this genus in the Pacific Basin. However, before going further, I want to publish an annotated list of the species of *Laurencia* recognized thus far, with an analytical key to indicate how they may be distinguished.

I express my sincere thanks to Dr. Maxwell S. Doty, University of Hawaii, and Dr. Isabella A. Abbott, Hopkins Marine Station of Stanford University, who gave me the opportunity to study and encouraged me during the course of the work. I am also grateful to Dr. Jun Tokida and Dr. Yukio Yamada, both of Hokkaido University, for their valuable advice and encouragement. Financial assistance from NIH grant EF 00938-01 and AEC contract AT-(04-3)-235 with the University of Hawaii also is gratefully acknowledged.

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At present it is recognized (Saito, 1967) that the genus is divisible into two subgenera based on the arrangement of the tetrasporangia and, as in the following key, on the structure of the outermost cortical layer. These useful features are illustrated in Figures 1–3, included here to define the related terms used in the keys and discussions below.

KEY TO THE SUBGENERA OF THE GENUS *Laurencia*

Secondary pit-connections present between the superficial cortical cells ..... Subgenus I. *Laurencia*

Secondary pit-connections absent between the superficial cortical cells ..... Subgenus II. *Chondrophycus*

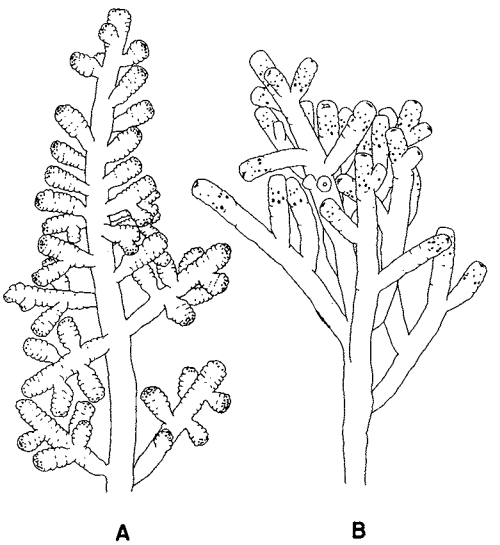

FIG. 1. Diagrams of the types of arrangement of tetrasporangia used in separating the subgenera. *A,* Right angle type; *B,* parallel type.

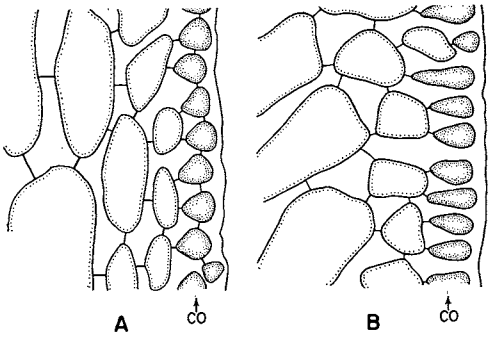

FIG. 2. Diagrams of longitudinal sections of branchlets showing presence (*A*) or absence (*B*) of secondary pits between adjacent superficial cortical cells (*CO*).

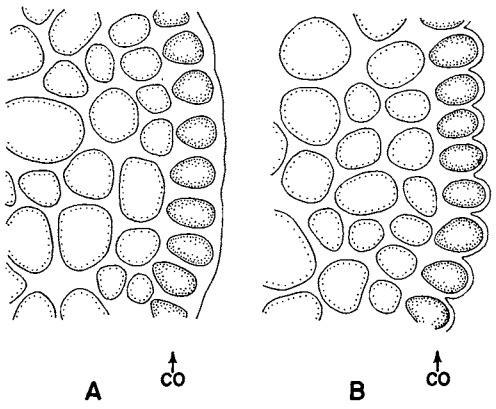

FIG. 3. Diagrams of the superficial cortical cells (*CO*) in reference to the surface of the thallus near the apices of the branchlets. *A*, Cortical cells not projecting; *B*, cortical cells projecting.

Subgenus I. *Laurencia*

This subgenus is characterized by the presence of secondary pit-connections between adjacent superficial cortical cells as well as by the tetrasporangia being arranged parallel to the axis in the apical portion of the ultimate branchlet bearing them. Nine species occur in the area studied here, and most of them were found to show these two characteristics. An exception is *L. subsimplex,* which is placed here in the section Pinnatifidae with some doubt.

KEY TO THE SECTIONS OF SUBGENUS I. *Laurencia*

1. Frond terete or subterete 2
1. Frond clearly compressed
Sect. 3. Pinnatifidae
2. Lenticular thickenings absent in the walls of the medullary cells ..... Sect. 1. Laurencia
2. Lenticular thickenings present in the walls of the medullary cells .. Sect. 2. Forsterianae

Section 1. Laurencia

The frond is usually terete. Lenticular thickenings are absent in the walls of the medullary cells. The cortical cells are neither elongated radially nor arranged like palisade cells when seen in a transection. Most of the members have a soft and fleshy texture and adhere well to paper when dried there under gentle pressure. The few species which are cartilaginous never so adhere.

KEY TO THE SPECIES AND THE VARIETIES OF SECTION 1. Laurencia

1. Cortical cells projecting above the surface near the end of the ultimate branchlets
L. majuscula
1. Cortical cells not projecting 2
2. Frond up to 1 cm at maturity .... *L. tenera*
2. Frond taller at maturity 3
3. Frond cartilaginous and rigid 4
3. Frond soft and fleshy 5
4. Branches very few .. *L. obtusa* var. *rigidula*
4. Branches not as above, especially abundant in the upper portion
L. obtusa var. *dendroidea*
5. Especially the main axis over 1 mm thick
L. obtusa var. *snackeyi*
5. Main axis less than 1 mm thick
L. obtusa var. *obtusa*

Laurencia majuscula (Harv.) Lucas, in Lucas and Perrin, 1947, p. 249
L. obtusa (Huds.) Lamouroux var. *majuscula* Harvey, in Yamada, 1931, p. 223, pl. 16, fig. c.

HABITAT: Midway, Laysan, Kauai, Oahu, and Maui in the Hawaiian Islands; Albay and Pan-

gasinan provinces, Philippines (Doty 8002, 8075, 8175(?),* 8209, 8411, 8886(?), 8979, 10040, 10103, 10248(?), 12355, 12935, 14262, 14377, 14806, 15413, 15360a, 15992, 16334, 16935, 16952, 21751, 22075(?), 23313, 23654; R. Tsuda 524(?), 564, 582(?), 616, 907, 917(?), 931, 940(?), 963(?), 964, 982(?), 983, 1015a; D. P. Rogers, no numbers 11-V-1946, 30-V-1946, 14-V-1946).

DISTRIBUTION: Western Australia (type locality), southern Japan, warmer parts of the Atlantic, Pacific, and Indian oceans.

The frond is usually a beautiful red. The texture is soft and fleshy, and the thalli adhere well to paper upon drying. The superficial cortical cells clearly project above the surface in the apical portion of an ultimate branchlet. Some specimens closely resemble *L. mariannensis* Yamada in external appearance but are easily distinguishable by the absence of the characteristic lenticular thickenings which are present in the latter species. There are some slender specimens among the above Philippine collections. I believe this is a distinct species and not a variety of *L. obtusa.* Recently Dr. Y. Yamada (private communication) has concurred in this opinion.

Laurencia tenera Tseng, 1943, p. 200, pl. 1, fig. 6, pl. 2, figs. 5 and 6; Dawson, 1954, p. 458, fig. 62*b* and *c*
Fig. 4*A*

HABITAT: Oahu, Hawaiian Islands (Doty 14813).

DISTRIBUTION: Hong Kong (type locality); Vietnam.

The frond forms a mat-like colony of small, delicate branches, up to 1 cm high, yellowish brown in colour. It adheres well to paper when dried. The superficial cortical cells never project above the surface.

Laurencia obtusa (Huds.) Lamouroux var. *obtusa* Lamouroux, 1813, p. 42; Yamada, 1931, p. 222

HABITAT: Albay Province, Philippines (Doty 16911).

DISTRIBUTION: Very widely distributed; the type locality is in England.

* Specimen numbers followed by (?) refer to specimens whose identification is not entirely certain.

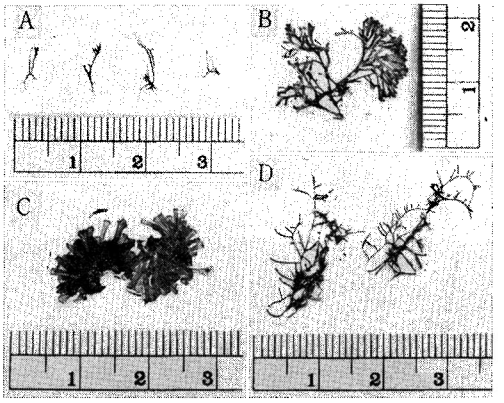

FIG. 4. *A, Laurencia tenera* (Doty 14813). *B, Laurencia galtsoffi* (Doty 10250). *C, Laurencia subsimplex* (Doty 16731). *D, Laurencia decumbens* (Doty 14812). (Scales in centimeters.)

Only a few specimens on one sheet are referable to this variety. The frond is soft and fleshy, and the thalli adhere well to paper upon drying. The superficial cortical cells never project above the surface in the apical portion of an ultimate branchlet.

Laurencia obtusa (Huds.) Lamouroux var. *dendroidea* (J. Ag.) Yamada, 1931, p. 224, pl. 17, fig. a

HABITAT: Mindanao, Philippines (Doty 18337).

DISTRIBUTION: Brazil (type locality).

Only Philippine specimens have been seen. The ultimate branchlets are somewhat crowded in the apical portion. The superficial cortical cells never project above the surface in the apical portion of an ultimate branchlet.

Laurencia obtusa (Huds.) Lamouroux var. *rigidula* Grunow, 1874, p. 23; Yamada, 1931, p. 225; Børgesen, 1945, p. 58, figs. 34 and 35

HABITAT: Kauai, Oahu, Molokai, and Maui in the Hawaiian Islands; Fiji Islands (Doty 8715, 9887, 10039, 10080, 10096, 10148, 10331, 12950, 13016, 13414, 14828; W. Greenwood 2004a).

DISTRIBUTION: Samoa (type locality); Mauritius.

The frond is rigid, dark brown in colour, forming a scrub-brushlike clump standing on a well developed discoid base. Branches are few,

especially in the basal half which is usually naked.

Laurencia obtusa (Huds.) Lamouroux var. *snackeyi* (W. v. Bosse) Yamada, 1931, p. 225, pl. 16, fig. b

HABITAT: Mindanao, Philippines (Doty 18170).

DISTRIBUTION: Samau, near Timor (type locality); Palau Islands.

Only one specimen from the Philippines is referable to this variety. The frond is thick and coarse, especially in its more basal portions. The thalli adhere well to paper upon drying.

Section 2. Forsterianae Yamada

The frond is usually terete. Lenticular thickenings are present in the medullary cell walls. The cortical cells are neither elongated radially nor arranged in transection like palisade cells. The thalli adhere to paper upon drying, but usually adhesion is not strong.

KEY TO THE SPECIES OF SECTION 2. Forsterianae

1. Superficial cortical cells projecting near the ends of ultimate branchlets 2
1. Superficial cortical cells not as above ... 3
2. Frond less than 2 cm high, branching sometimes dichotomo-corymbose .... *L. galtsoffi*
2. Frond taller, branching not as above *L. mariannensis*
3. Frond thin and delicate, branching usually secund ..... *L. decumbens*
3. Frond not as above 4
4. Basal stoloniferous branches absent *L. japonica*
4. Frond usually with stoloniferous basal branches ..... *L. nidifica*

Laurencia galtsoffi Howe, 1934, p. 39, fig. 5
Fig. 4*B*

HABITAT: Laysan and Kauai, Hawaiian Islands (Doty 10003, 10250, 10286; R. Tsuda 515, 604, 935).

DISTRIBUTION: Endemic (type locality is Hawaii).

Before studying the type specimen of this species, I identified these specimens as *L. mariannensis* Yamada. While there are some differences between the two (*L. galtsoffi* and *L. mariannensis*), I am not sure whether they should be treated as independent species. The cortical cells in the materials which I studied clearly project above the surface near the ends of the ultimate branchlets as they do in the type specimen of *L. galtsoffi*. I think that ultimately the present species must be combined with *L. mariannensis* Yamada or *L. pannosa* Zanardini, or may be regarded as but a form of one of them. Unfortunately, I was unable to observe any fresh materials of either *L. mariannensis* or *L. pannosa;* therefore, all taxa are retained.

Laurencia mariannensis Yamada, 1931, p. 200, pl. 5, fig. b, text-figs. F and G; Taylor, 1950, p. 144, pl. 55, fig. 1; Dawson, 1956, p. 60, fig. 66

HABITAT: Laysan and Lanai, Hawaiian Islands; Gilbert Islands; Philippines (Doty 16251, 18787, 18869, 18881, 18926, 19588, 21615, 21723, 22090(?), 22107, 22115(?), 23105; R. Tsuda 514, 524, 904, 963).

DISTRIBUTION: Saipan, Mariannas Islands (type locality); Uliga, Eniwetok, and Bikini, Marshall Islands.

The frond is tufted below, erect, up to 4 cm high, paniculately branched. The texture is soft and the thalli adhere to paper upon drying; the colour is purplish brown (specimens are somewhat bleached). Superficial cortical cells in the apical portion of an ultimate branchlet project above the surface. In external appearance some specimens resemble *L. majuscula,* but internally they are easily distinguishable by the presence of lenticular thickenings which are absent in the latter species. In the projection of superficial cortical cells and the presence of lenticular thickenings, *L. mariannensis* also resembles *L. galtsoffi,* but this latter species is usually smaller and most of the specimens show the dichotomo-corymbose branching as described by Howe (1934).

Laurencia decumbens Kützing, 1865, p. 18, pl. 51, figs. a and b; Børgesen, 1945, p. 50, figs. 25–27
Fig. 4*D*

HABITAT: Kauai and Oahu, Hawaiian Islands (Doty 8719, 14812).

DISTRIBUTION: New Caledonia (type locality); Mauritius.

In the herbarium of Dr. Doty, only two specimens were seen. The frond is about 2 cm high, forming a matlike colony, with some stoloniferous basal branches, loosely intricate below, and delicate. The colour is purplish brown. Some branches are characteristically arcuate, and along their outer sides the branchlets are arranged secundly.

L. japonica Yamada, 1931, p. 211, pl. 11, figs. a and b, text-fig. L; Tseng, 1943, p. 197

HABITAT: Quezon Province and Palawan Island, Philippines (Doty 16447; University of the Philippines 74-5899).

DISTRIBUTION: Japan (type locality); Hong Kong (Tseng).

Few specimens among Dr. Doty's collections are referable to this species. All of them were collected in the Philippines. Some look like juvenile fronds of *L. papillosa* in external appearance, but are clearly different in having lenticular thickenings in the medullary cell walls, and in never having the cortical cells elongated or arranged, in transection, like palisade cells.

Laurencia nidifica J. Agardh, 1863, p. 749; Yamada, 1931, p. 202; Børgesen, 1945, p. 47, figs. 21–24

Fig. 5

HABITAT: Kauai, Oahu, Molokai, and Lanai, Hawaiian Islands (Doty 8444, 8595, 8617, 8931, 9894, 10251, 14726–14735, 14740–14755, 14814–14817, 19497, 20339, 20340, 22026; Degener 28688; D. P. Rogers, no number 27-II-1946).

DISTRIBUTION: Hawaii (type locality); Mauritius.

The frond is erect, up to nearly 10 cm high, with several erect axes tufted below with entangled basal stoloniferous branches. The erect axes are cylindrical and paniculately branched. The texture is more or less cartilaginous but not very rigid, and the thalli adhere to paper upon drying. Superficial cortical cells do not project above the surface even in the apical portion of an ultimate branchlet.

In Hawaii, the species is very variable in general shape as well as in colour. At places which face the open sea, for example, at the entrance to Hanauma Bay, some characteristically matlike colonies of dwarf, dark purplish thalli are found. These have very few rhizoidal branches. This form was also collected at Laie

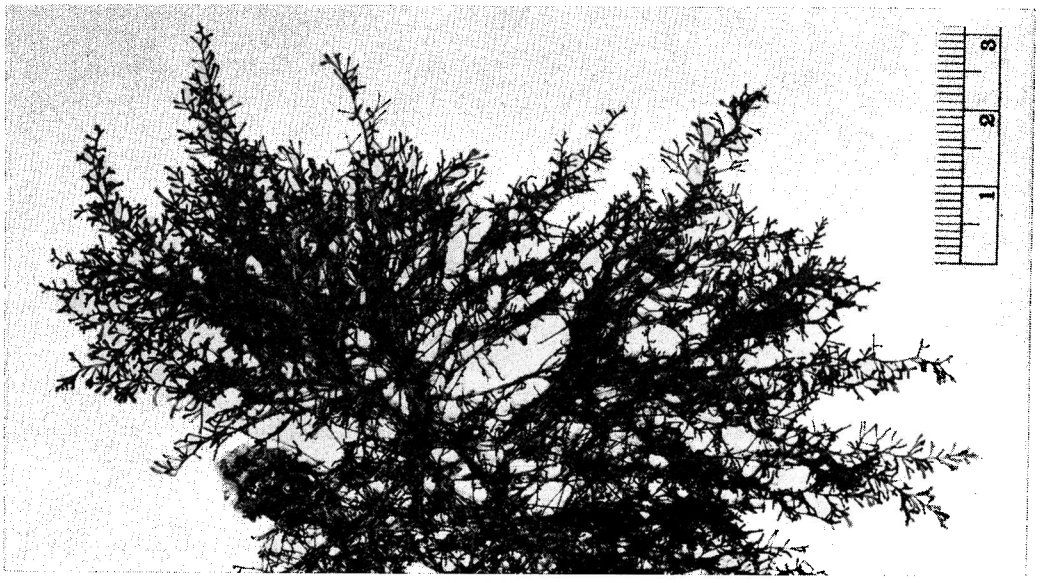

FIG. 5. *Laurencia nidifica* (Doty 14729). (Scale in centimeters.)

Point by Dr. Doty (8931). On the other hand, inside of the reef, for instance, near the natatorium in Waikiki, frequently there are slender thalli forming loosely entangled spherical colonies on rocks, dead coral, and other coarse algae. Their colour is usually purplish pink or yellowish purple, sometimes slightly greenish.

At about sea level, on dead coral just north of the mouth of Kuloa stream, Oahu, there are attractive green, soft plants. On the outer reef at the same place, in water about 1 m deep at low tide, there are coarse purplish plants on which many melobesioid algae grow. On the upper sides of some rocks at Diamond Head Beach, green thalli are to be found. They are somewhat more slender than those from the Kuloa site, and with fewer branches in their lower halves.

All of these forms are identified as *L. nidifica* because there are no essential differences among them—in the shape of reproductive organs, the presence of lenticular thickenings, or other anatomical structures.

Section 3. Pinnatifidae J. Agardh

The frond is clearly compressed, pinnately branched and with or without lenticular thickenings in the walls of the medullary cells. Only one species from the area under study is placed in this section.

Laurencia subsimplex Tseng, 1943, p. 202, pl. 3, figs. 4 and 6
Fig. 4*C*

HABITAT: Midway Island, Hawaii; Catanduanes Province, Philippines (Doty 16731, 18708).

DISTRIBUTION: Hong Kong (type locality).

Few specimens in Dr. Doty's herbarium are referable to this species. The frond forms a clump with several compressed axes which are almost naked in the Philippine specimens (16731, Fig. 4*C*) but more or less branched in the Midway specimens (18708). The texture is soft and the thalli adhere to paper upon drying.

Since all of the specimens of this species studied are sterile, I could not determine the arrangement of the tetrasporangia. Moreover, the presence of secondary pit-connections between the superficial cortical cells is not clear. Thus the present species is classified as a member of Section 3. Pinnatifidae with some doubt.

Subgenus II. *Chondrophycus* Tokida et Saito

This subgenus is characterized by the absence of secondary pit-connections between the superficial cortical cells as mentioned in the key to the subgenera, as well as by the tetrasporangial arrangement which is uniformly of the right angle type in the apical portion of the fertile ultimate branchlets. Lenticular thickenings of the medullary cell walls are absent. Twelve species occur in the area studied, most of which show these two characteristics; in a few species, however, tetrasporophytes were not seen. These points are discussed in the remarks on the corresponding species.

KEY TO THE SECTIONS OF SUBGENUS II. *Chondrophycus*

Superficial cortical cells elongated radially and arranged in a transection like palisade cells
Sect. 5. Palisadae

Superficial cortical cells not as above
Sect. 4. Chondrophycus

Section 4. Chondrophycus

The frond is usually cartilaginous. The superficial cortical cells are neither elongated radially nor arranged in a transection of the frond like palisade cells. The ultimate branchlets are not compressed, even in the species which have compressed branches.

KEY TO THE SPECIES OF SECTION 4. Chondrophycus

1. Branches terete 2
1. Branches compressed 3
2. Superficial cortical cells projecting near the ends of ultimate branchlets .. *L. carolinensis*
2. Superficial cortical cells not as above
L. cartilaginea
3. Superficial cortical cells projecting near the ends of ultimate branchlets ..... *L. dotyi*

3. Superficial cortical cells not as above ... 4
4. Margins of the branches undulate, colour blackish ..... *L. undulata*
4. Margins of the branches not as above, colour reddish ..... *L. succisa*

Laurencia carolinensis sp. nov.
Figs. 6 and 7*A, B, C*

Plantae fasciculos aliquot axium erectorum formantes, sine ramis basalibus stoloniferis, cartilaginosae, ubique cylindricae. Rami determinati prope apices densi, axibus ramulisque paululum nudis. Medulla e cellulis magnis, membranas crassas habentibus composita, sine incrassatione lenticulari. Cellulae corticeae ultra superficiem thalli eminent, tubera regularia semicircularia efficientes.

Forming clumps of but few erect axes arising from a discoid holdfast, without stoloniferous basal branches, up to about 5 cm high, cartilaginous, cylindrical throughout. Branching alternate, opposite, or sometimes dichotomous. Main axis usually percurrent but sometimes not clear. Determinate branchlets densely disposed on the upper branches, simple or bearing a few minor branchlets, clavate and slightly swollen at the apices; the axes and branches somewhat naked at the base. The determinate branchlets longest along the middle portion of the branch, about 1.5 mm long becoming shorter toward the distal and proximal ends. The medulla made up of large cells with very thick walls, but without lenticular thickenings. The superficial cortical cells in transection neither elongated radially nor arranged like palisade cells, being 28–34μ long radially and 22–32μ in diameter at the branchlets. They project prominently at the ends of the branchlets, almost half their length being beyond the general surface of the thallus and thus producing regular semi-circular bumps.

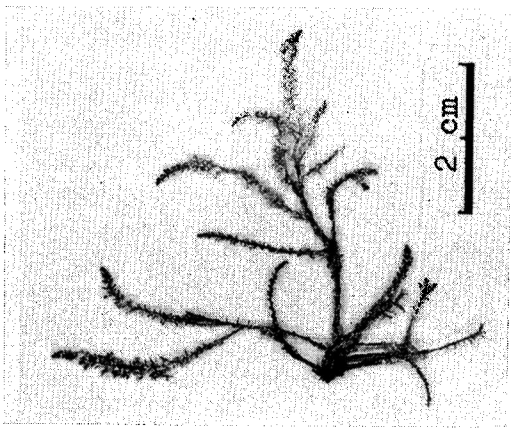

FIG. 6. *Laurencia carolinensis* sp. nov., type specimen (Doty 15360).

TYPE SPECIMEN: Doty 15360, on sandy-rocky bottom in southeastern region of Helen Reef, western Caroline Islands, 28-VIII-1960. It has been also collected at the south end of Helen Reef (Doty 15740).

This species reminds one of some form of *L. papillosa,* especially in the presence of the densely crowded branchlets disposed in all directions, but the thalli do not show the palisade-like cortical cells. On the other hand, it is somewhat similar to *L. tropica* Yamada and *L. columellaris* Børgesen. However, these two species do not have superficial cortical cells that project near the ends of the branchlets, which feature is easily observed in *L. carolinensis.* The tetrasporangial arrangement could not be determined because the specimens are all sterile.

Laurencia cartilaginea Yamada, 1931, p. 230, pl. 19, fig. a, text-fig. 0
Fig. 8*B*

HABITAT: Oahu, Hawaiian Islands; Surigao, Philippines; Singapore (Doty 14408, 14756–14759, 14768, 14769, 18809, 25601).

DISTRIBUTION: Japan (type locality).

The frond forms a clump without rhizoidal basal branches, paniculately branched, up to 8 cm high, usually cylindrical near the base, angular upward, sometimes partly compressed, dark purple or purplish green in colour when fresh, changing to black upon drying, cartilaginous and rigid in texture, never adhering to paper when dried. In compressed portions, branching usually pinnate. There are two forms of main branches, one with a percurrent axis, the other divided into two or more main branches near the base.

Laurencia dotyi sp. nov.
Figs. 9*A, B, C* and 10 *A, B*

Plantae cartilaginosae, fasciculos paucorum axium erectorum ex haptero discoideo eminentium formantes. Axes erecti ramique paululum sed semper compressi, axibus plerumque percurrentibus. Ramuli ultimi numquam compressi. Medulla e cellulis rotundis polygonalibusve sine incrassatione lenticulari composita. Cellulae corticales ultra superficiem thalli eminent.

Forming clumps which have but a few erect axes standing on a discoid holdfast, without stoloniferous basal branches, up to about 5 cm high, cartilaginous. The erect axes slightly but constantly compressed, usually percurrent, broadest in the middle part, and there up to 1.8 mm broad and 1 mm thick. Branching alternately or oppositely distichous. The branches also slightly compressed, longest at the middle portions, becoming prominently shorter toward the base and gradually shorter toward the upper portions. The ultimate stichidial branchlets up to 1 mm long, never compressed, clavate, truncate, or rounded at the apices. Colour brownish

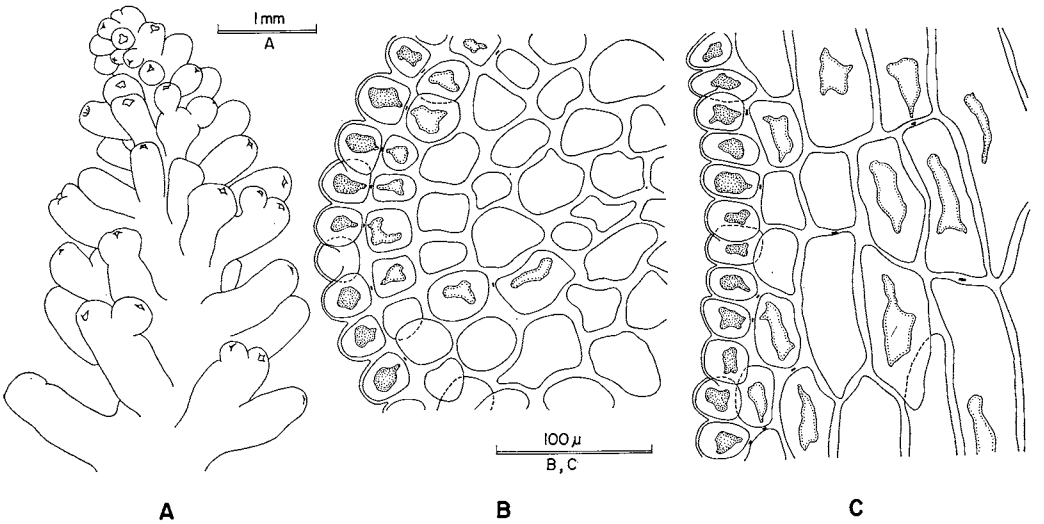

FIG. 7. *Laurencia carolinensis* sp. nov. *A,* Upper portion of a thallus; *B,* transverse section of an ultimate branchlet; *C,* longitudinal section of an ultimate branchlet. (All the figures were drawn from an isotype specimen: Doty 15360.)

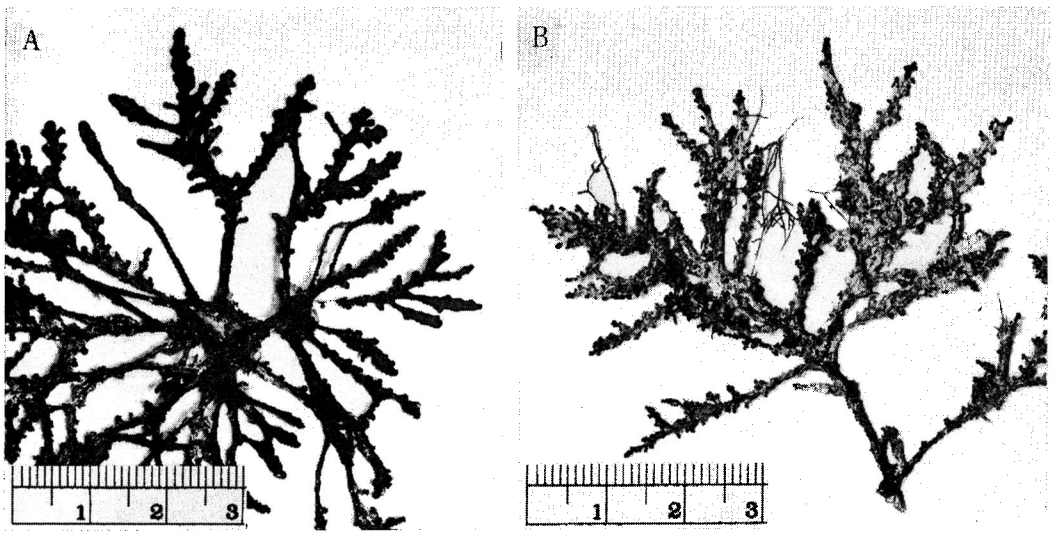

FIG. 8. *A, Laurencia undulata* (Doty 14823). *B, Laurencia cartilaginea* (Doty 14759). (Scales in centimeters.)

purple or somewhat greenish when fresh, changing to black upon drying. The tetrasporangial arrangement of the right angle type. No secondary pit-connections present between adjacent superficial cortical cells; the latter in transection neither elongated radially nor arranged like palisade cells, 17–35μ long by 12–30μ in diameter. They project prominently at the ends of the branchlets, almost one third of their length being above the surface. Medullary cells without lenticular thickenings in the walls, round or polygonal, up to 190μ in diameter.

TYPE SPECIMEN: Doty 14822, on reef near Buoy 23, Kaneohe Bay, Oahu, Hawaii (col-

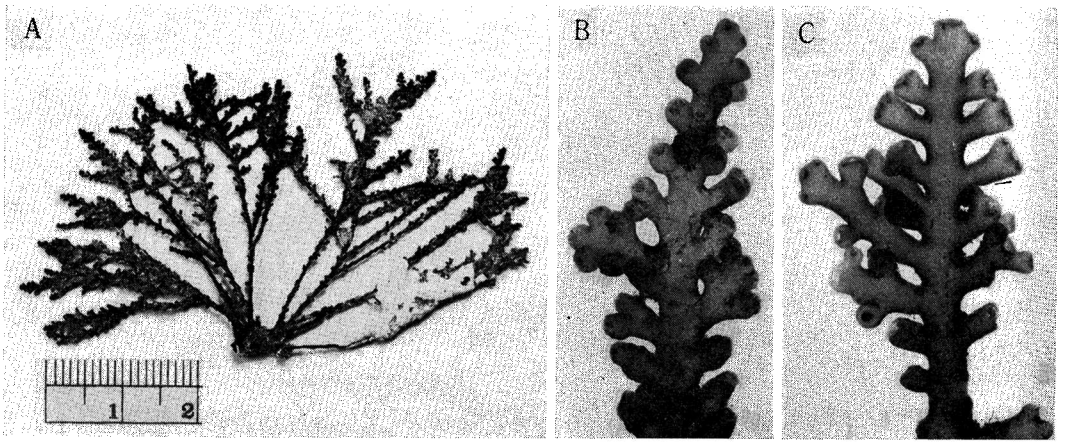

FIG. 9. *Laurencia dotyi* sp. nov. *A,* The type specimen (Doty 14822); *B,* upper portion of a tetrasporangial thallus from the type collection, × 4; *C,* upper portion of a male thallus from the type collection, × 4. (Scale in centimeters.)

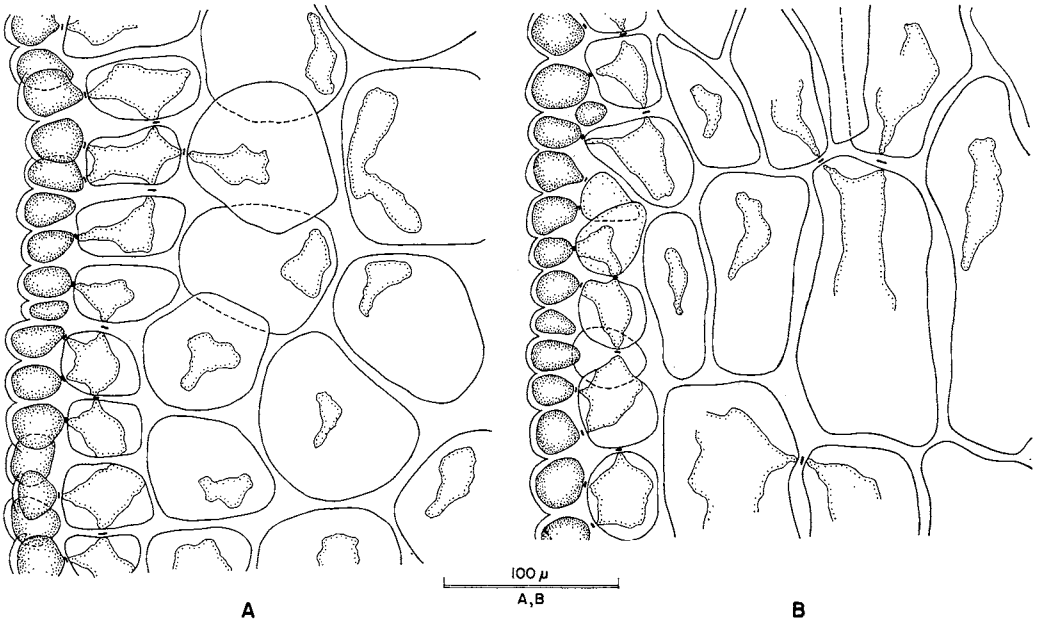

FIG. 10. *Laurencia dotyi* sp. nov. *A,* Transverse section of an ultimate branchlet; *B,* longitudinal section of an ultimate branchlet. (Both figures were drawn from the type collection.)

lected by G. Trono), 3-II-1967. Also collected by the writer at about sea level on rock, seaward of the natatorium in Waikiki, Oahu, 23-XII-1966 (Doty 14818 and 14819), and on the rock bench along the north side of the entrance to Hanauma Bay, Oahu, 14-I-1967 (Doty 14820). The following specimens collected on Kauai, Oahu, Molokai, and Maui, Hawaiian Islands, are also this species: Doty 8362 (in part), 9893, 9966, 10088, 10252, 12987(?), 13251(?), 19507, 15684; R. Tsuda 573.

Male specimens from the type collection show antheridial branchlets as usually simple and clavate. Cystocarpic thalli have not been found.

L. dotyi is somewhat close to *L. parvipapillata,* especially in the projection of its apical cortical cells, as well as in the compressed frond. It differs from that species in its narrower and more slender appearance. Furthermore, the cortical cells are strongly elongated and clearly arranged like palisade cells in *L. parvipapillata,* which is not the case in *L. dotyi.*

Laurencia undulata Yamada, 1931, p. 243, pl. 29, fig. a, text-fig. T; Tseng, 1943, p. 206
Fig. 8*A*

HABITAT: Oahu, Hawaiian Islands (Doty 8362, 8513, 9985, 14774, 14823).

DISTRIBUTION: Japan (type locality); Hong Kong.

This species occurs with *L. cartilaginea* in Kaneohe Bay, Oahu. Among collections, there sometimes appear compressed individuals which are usually pinnately branched. I have separated them from *L. cartilaginea,* although, except for this difference in branching, the two species are identical, even considering the Japanese materials seen. Sometimes both kinds of branching are seen in the same clump. Therefore, it is probable that after more detailed study we will come to regard this species as but one form of *L. cartilaginea.*

Laurencia succisa Cribb, 1958, p. 168, pl. 1, figs. 1–3

HABITAT: Kauai, Oahu, Lanai, and Maui, Hawaiian Islands (Doty 8613, 9891, 9892, 10054, 12932, 13177, 14809–14811).

DISTRIBUTION: Australia (type locality).

The frond is cartilaginous and rigid, up to 5 cm high, pinnately branched, cylindrical near the base, and there less than 1 mm in diameter, compressed upward, up to 2 mm broad, dark purple or olive in colour, and not adhering to paper upon drying.

This description is similar to that of *L. parvipapillata,* but the superficial cortical cells of *L. succisa* are neither elongated radially nor arranged in a palisade. Also they do not project above the surface even in the apical portions, as they do characteristically in *L. parvipapillata.*

Section 5. Palisadae Yamada

Frond usually cartilaginous. Superficial cortical cells elongated radially and arranged in transection as a palisade; in only one species do they project above the surface in the apical portions of the ultimate branchlets.

KEY TO THE SPECIES OF SECTION 5. Palisadae

1. Frond clearly compressed *L. parvipapillata*
1. Frond terete or subterete 2
2. Branchlets usually very abundant *L. papillosa*
2. Branchlets not as above 3
3. Branching sparse ..... *L. flagellifera*
3. Branching not as above 4
4. Branching usually secund ... *L. surculigera*
4. Branching usually paniculate 5
5. Frond rigid, reddish ..... *L. paniculata*
5. Frond not very rigid, blackish *L. yamadana*

Laurencia yamadana Howe, 1934, p. 37, fig. 4
L. amabilis Yamada, in Yamada and Segawa, 1953, p. 13, figs. 6 and 7
Fig. 11*A*

HABITAT: Oahu, Molokai, and Maui, Hawaiian Islands (Doty 8111, 8407, 8659, 9984, 10724, 12190, 12908, 13019, 13166, 14760–14767, 14821, 15868, 21760, 21915, 23716).

DISTRIBUTION: Hawaii (type locality); Japan.

This species was established by Howe (1934) on the basis of a fragment collected by Galtsoff

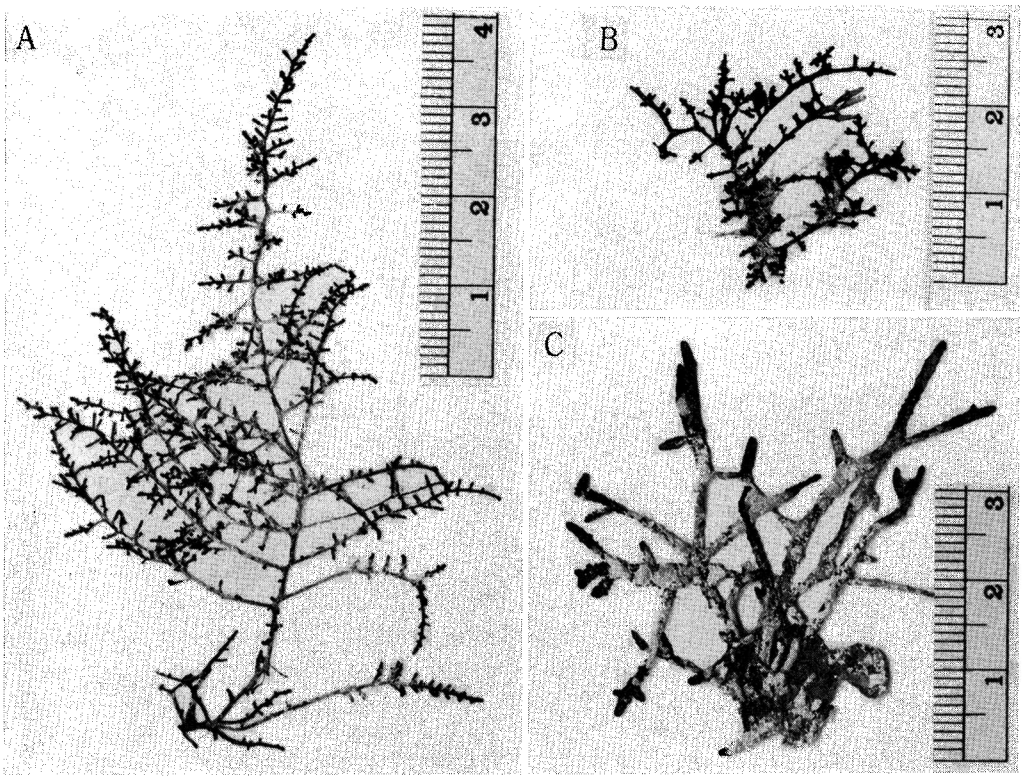

FIG. 11. *A, Laurencia yamadana* (Doty 14766). *B, Laurencia surculigera* (Doty 8187). *C, Laurencia parvipapillata* (Doty 14807). (Scales in centimeters.)

in Kaneohe Bay, Oahu, Hawaii. The colour of this fragment may have been bleached, and thus his description may not be normal for the species. Later, Yamada (Yamada and Segawa, 1953) established another species, *L. amabilis,* on the basis of materials from Hachijo Island, one of the southeastern islands of Japan. He noted that *L. amabilis* "seems to relate most closely to *L. yamadana* Howe from Hawaii." As a matter of fact, I identified the above-listed specimens as *L. amabilis* before seeing the type specimen of *L. yamadana.* They conform to both Yamada's description and his specimens. There is no important difference between the two species. Recently, Dr. Yamada has concurred in this opinion (personal communication).

Laurencia paniculata (C. Ag.) J. Agardh, 1863, p. 775; Yamada, 1931, p. 192, pl. 3, fig. a; Tseng, 1943, p. 191

HABITAT: Oahu and Lanai, Hawaiian Islands (Doty 12974(?), 14770–14773, 22050; Otto Degener 28690; D. P. Rogers, no number 14-IV-1946).

DISTRIBUTION: Adriatic Sea (type locality); Vietnam; Hong Kong; Pacific Mexico.

Frond forming a clump without rhizoidal basal branches, paniculately branched, up to nearly 6 cm high, cylindrical throughout, purplish red when fresh, changing to somewhat blackish upon drying, cartilaginous and rigid in texture, never adhering well to paper when dried.

Laurencia papillosa (Forsk.) Greville, 1830, p. 52; Yamada, 1931, p. 190, pl. 1, figs. a and b

HABITAT: Catanduanes Province and several other places in the Philippines; Indonesia; Thailand (Doty 14322, 14387, 14391, 14413, 16014, 16388, 16447, 16548(in part), 16795,

16980, 18046, 18169, 25361, 25371, 25385, 25628).

DISTRIBUTION: Red Sea (type locality), widely distributed in most warm seas.

This species is usually easy to identify. It is very attractive in its abundance of branchlets. Nevertheless, other species sometimes show similarities in appearance. One of these is *L. cartilaginea.* However, it does not have the palisade-like superficial cortical cells which are an important characteristic of *L. papillosa. L. carolinensis* also is somewhat close to *L. papillosa,* especially in the abundance of branchlets. For differences between these two species, see the remarks under *L. carolinensis,* above.

Laurencia flagellifera J. Agardh, 1863, p. 747; Yamada, 1931, p. 197, pl. 4, fig. b; Børgesen, 1937, p. 50, fig. 28

HABITAT: Maui, Hawaiian Islands (Doty 12986).

DISTRIBUTION: India (type locality); Australia.

Only one specimen among Dr. Doty's collections is referable to this species. Its superficial cortical cells are elongated radially and arranged in transections like palisade cells, but the elongation of these cells is not as marked as in other members of Section 5. Palisadae. There are attractive annular scars around the frond which look like articulations. The tetrasporangial arrangement could not be determined because the specimen is sterile.

Laurencia surculigera Tseng, 1943, p. 192, pl. 1, figs. 4 and 5

Fig. 11*B*

HABITAT: Laysan, Oahu, and Maui, Hawaiian Islands (Doty 8045, 8187, 12984, 12985; R. Tsuda 560).

DISTRIBUTION: Hong Kong (type locality).

The frond is usually slightly compressed, up to 5 cm high, forming a clump with several main branches tufted below. The colour is purplish brown, and the texture somewhat cartilaginous. The thalli never adhere well to paper when dried. Some main branches are attractively arcuate, and, from their outer sides, secondary branches are arranged secundly. No tetrasporangia have been observed.

Some specimens in Dr. Doty's collections are close to *L. perforata* (Bory) Montagne. On the other hand, there are also specimens which are close to *L. moretonensis* Cribb. Unfortunately, the relationship of these specimens could not be determined. Therefore, they are listed here with their closest relative, *L. surculigera.* (Doty 8436, 12190, 16498, 16618, 16725, 18902. These specimens are from Maui, Hawaiian Islands; the Gilbert Islands; and the Philippines.)

Laurencia parvipapillata Tseng, 1943, p. 204, pl. 4; Dawson, 1954, p. 458, fig. 61*g*

Fig. 11*C*

HABITAT: Midway, Oahu, Maui, and Hawaii, Hawaiian Islands; Palawan Province, Philippines (Doty 8186, 8362[in part], 10657, 12977, 13515, 14807, 14808, 14825, 16564, 18754 L, 20191).

DISTRIBUTION: Hong Kong (type locality); Vietnam.

The frond is cartilaginous and very rigid, up to 5 cm high, pinnately branched, constantly and strongly compressed, up to 2.5 mm broad, cylindrical near the very base, less than 1 mm in diameter there, purplish red in colour, never adhering to paper when dried. In transverse sections the superficial cortical cells are very strongly elongated radially. They project conspicuously above the surface on the upper portions of branchlets. Although I have not observed any tetrasporophytes of this species, Tseng's illustration (1943) shows clearly the tetrasporangial arrangement to be of the right angle type.

L. parvipapillata closely resembles *L. succisa,* especially in its compressed appearance, but it is easily distinguished by the projection of the superficial cortical cells on the upper portions. Also, of course, a transverse section shows clearly the palisade-like arrangement of these cells. Most of the specimens from the Hawaiian Islands are much coarser than those from the Philippines, which latter quite surely are within the original circumscription of Tseng (1943). However, I identify these specimens from Hawaii confidently with *L. parvipapillata.*

LITERATURE CITED

AGARDH, J. G. 1863. Species genera et ordines algarum, vol. 2, no. 3, pp. 701–1291. Lund.

BØRGESEN, F. 1945. Some marine algae from Mauritius. III. Rhodophyceae. Part 4, Ceramiales. K. Danske Videnskabernes Selskab. Biologiske Meddelelser, vol. 19, no. 10, pp. 1–68.

CRIBB, A. B. 1958. Records of marine algae from southeastern Queensland. III. *Laurencia.* Lamx. University of Queensland Papers, Botany, vol. 3, no. 19, pp. 159–191.

DAWSON, E. Y. 1954. Marine plants in the vicinity of the Institute Océanographique de Nha Trang, Viêt Nam. Pacific Science, vol. 8, no. 4, pp. 373–481.

——— 1956. Some marine algae of the southern Marshall Islands. Pacific Science, vol. 10, no. 1, pp. 25–66.

GREVILLE, R. K. 1830. Algae Britanicae, or descriptions of the marine and other inarticulated plants of the British Islands, belonging to the order Algae, with plates illustrative of the genera. Edinburgh, Maclachnan. 218 pp.

GRUNOW, A. 1874. Algen der Fidschi- Tonga- und Samoa-Inseln, gesammelt von Dr. E. Graefe. Journal des Museum Godeffroy, Hamburg, Heft 6, pp. 23–50.

HOWE, M. A. 1934. Hawaiian algae collected by Dr. Paul C. Galtsoff. Journal of the Washington Academy of Sciences, vol. 24, no. 1, pp. 32–42.

KÜTZING, F. T. 1865. Tabulae Phycologicae, Vol. XV. Leipzig.

LAMOUROUX, J. V. F. 1813. Essai sur les genres de la famille des Thalassiophytes non articulées. Annales du Muséum d'Histoire Naturelle, vol. 20, pp. 21–47, 115–139, 267–293, pls. 7–13.

LUCAS, A. H. S., and F. PERRIN. 1947. The seaweeds of South Australia. Part II, Red seaweeds. Adelaide. Pp. 111–458.

MONTAGNE, J. F. C. 1840. Plantes cellulaires. In: P. B. Webb et S. Bertholet, Histoire naturelle des îles Canaries, vol. 3, no. 2, Phytographia Section, p. 208. Paris.

SAITO, Y. 1967. Studies on Japanese species of *Laurencia,* with special reference to their comparative morphology. Memoirs of the Faculty of Fisheries, Hokkaido University, vol. 15, no. 1, pp. 1–81, 18 pls.

TAYLOR, W. R. 1950. Plants of Bikini . . . . Ann Arbor, University of Michigan Press. 227 pp.

TSENG, C. K. 1943. Marine algae of Hong Kong. IV. The genus *Laurencia.* Papers from the Michigan Academy of Science, Arts and Letters, vol. 28, pp. 185–208, pls. 1–4.

YAMADA, Y. 1931. Notes on *Laurencia,* with special reference to the Japanese species. University of California Publications in Botany, vol. 16, no. 7, pp. 185–310, 30 pls.

YAMADA, Y., and S. SEGAWA. 1953. On some new or noteworthy algae from Hachijo Island. Records of Oceanographic Works in Japan, vol. 1, no. 1, pp. 109–114.